Influence of Air Gap Under Bolus on dose calculation accuracy in the clinical 6 MV Photon Beam

Suman Gautam, PhD[1]; Rodney J. Sullivan, PhD[1], Teva Shapiro, MS[1] ; Rex A Cardan, PhD[1] ; Sean Jollota, PhD[1] Natalie N. Viscariello, PhD[1] ; Joel A Pogue, PhD[1] ; Richard A Poppl;e, PhD[1]

[1]University of Alabama at Birmingham

2026 JULY 19–22 VANCOUVER, BC
JOINT AAPM | COMP MEETING

ABSTRACT

Abstract

Purpose:

To investigate the effect of bolus–surface air gap on surface dose calculation for a clinical 6 MV photon beam.

Methods:

Surface dose was measured in a solid water phantom at an effective depth of 0.3 mm using a diode detector for square fields from 5×5 to 25×25 cm². Bolus thicknesses of 0.5, 1, and 2 cm were evaluated with bolus–surface air gaps ranging from 0 to 6 cm. Corresponding plans were calculated using the AcurosXB algorithm (Varian Medical Systems). Surface dose was normalized to the zero–air-gap condition, and an exponential model was used to describe the non-linear dependence on field size and air gap.

Results:

Both calculations and diode measurements showed field-size and bolus-thickness dependent sensitivity to bolus surface air gaps, with surface dose decreasing with increasing air gap and decreasing field size. For small fields (5x5-10x10 cm2), Acuros XB predicted surface dose within 5% for air gaps of 4, 3, 1 cm for bolus thickness of 0.5, 1, and 2cm respectively.

Conclusion:

Bolus–surface air gaps significantly reduce surface dose, particularly for small photon fields, and increasing bolus thickness alone does not fully mitigate this effect. The accuracy of AcurosXB decreases with increasing air gap and bolus thickness. Future work includes evaluation of modulation fields.

CONTACT

Suman Gautam
University of Alabama at Birmingham
Birmingham, USA
suman3119@uabmc.edu

INTRODUCTION

- Skin sparing is the important phenomenon for high energy photon beams.
- Air gaps between bolus and skin are common recurrence in radiation therapy. For example, in head and neck cancer patients, the bolus placed on the surface of thermoplastic mask, resulting in air gaps of centimeter.
- Accurate estimation of surface dose in radiotherapy is therefore critical, as it provides valuable information to ensure accurate dose to the surface.
- This project aims to determine the accuracy of surface dose prediction for the AcurosXB dose calculation algorithm in the presence of air gaps.

METHODS AND MATERIALS

- Surface dose was measured in a solid water phantom at an effective depth of 0.3mm using a diode detector for square FS from 5x5-25x25 cm^2.
- Bolus thickness of 0.5, 1 and 2cm were evaluated with bolus-surface air gaps ranging from 0 to 6 cm.
- Corresponding plans were calculated using AcurosXB Algorithm.
- Surface dose was normalized to the zero-air-gap condition.

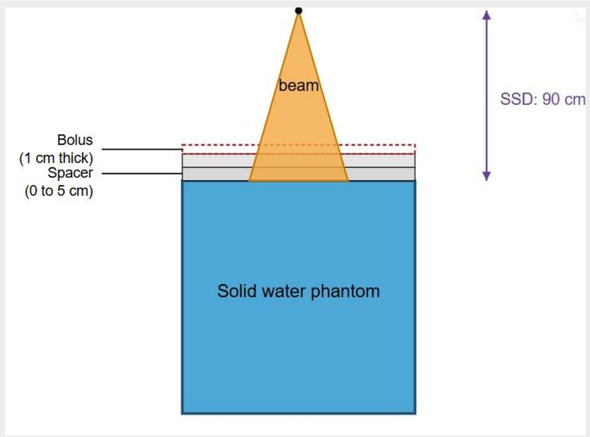
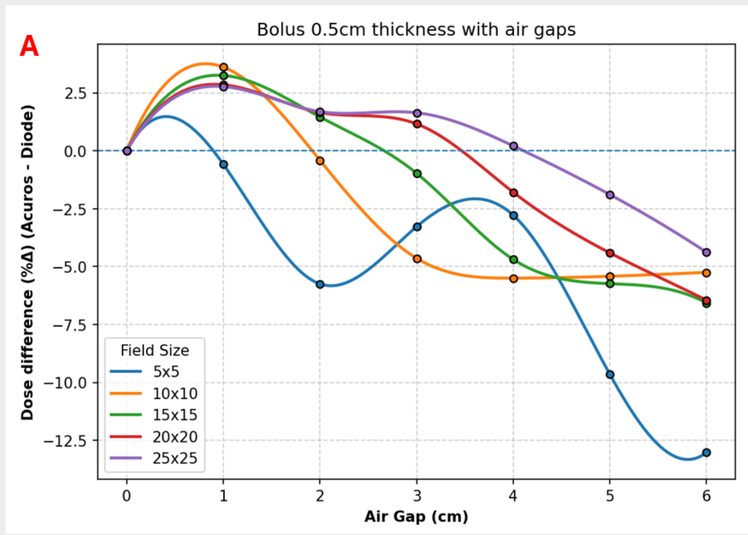
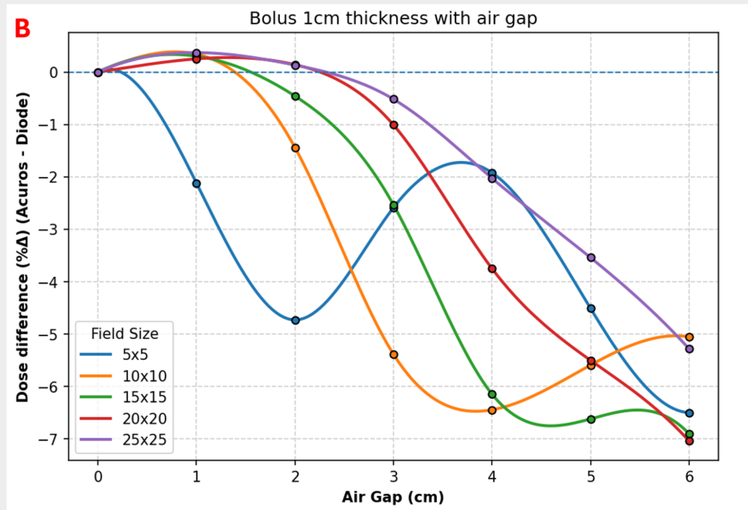


Figure 1. Geometrical setup for surface and depth measurements using solid water phantom.

RESULTS





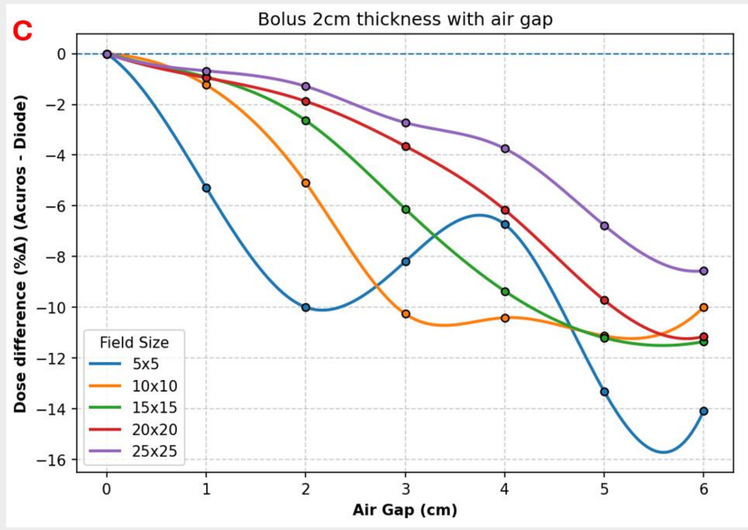


Figure 2. Percentage difference in surface dose (Δ) between AcuroXBs and diode relative to surface dose for 6MV beams 5x5 cm^2, 10x10 cm^2, 15x15xcm^2, 20x20cm^2, and 25x25cm^2 for bolus thickness 0.5cm (A), 1cm (B) and 2cm (C) gap with various air gap on the solid water. Each curve is normalized to 100% on the surface of solid water with 0 cm gap which was modeled with AcurosXB.

DISCUSSION

Figure 2, illustrates the decrease on surface dose (Δ) between the AcurosXB calculations and diode measurements. Surface dose decrease nonlinearly with increasing air gaps, with larger field sizes and thinner bolus showing the greatest reduction. AcurosXB predicted surface dose within 5% for air gaps of 4, 3,1 cm bolus thickness of 0.5, 1, and 2cm respectively.

CONCLUSIONS

Bolus-surface air gaps significantly reduce surface dose, particularly for small photon fields, and increasing bolus thickness alone doesn't fully mitigate this effect. The accuracy of AcurosXB decreases with increasing air gap and bolus thickness.

REFERENCES

1. Y. Khan, J. Villarreal-Barajas, M. Udowicz, R. Sinha, W. Muhammad, A. Abbasi and A. Hussain, "Clinical and Dosimetric Implications of Air Gaps between Bolus and Skin Surface during Radiation Therapy," *Journal of Cancer Therapy*, Vol. 4 No. 7, 2013, pp. 1251-1255. doi: 10.4236/jct.2013.47147.
2. Lobo D, Banerjee S, Srinivas C, Ravichandran R, Putha SK, Prakash Saxena PU, et al. Influence of air gap under bolus in the dosimetry of a clinical 6 MV photon beam. J Med Phys 2020;45:175-81.

THE UNIVERSITY OF ALABAMA AT BIRMINGHAM